scales between the supraoculars and upper palpebrals; the 4th, 5th and 6th supraciliaries are large and about the size of the 1st; the upper and lower palpebral chains both abut against the 4th, which is also in contact with the 3rd supraocular, 5th supraciliary and 2nd postocular; the 5th and 6th both touch the parietal and the 6th also the upper secondary temporal and primary temporal. There are three well-developed supraoculars, subequal in size; the frontal is in contact with the 1st only, the frontoparietal with all three, and the parietal with the 3rd. The mental is large, semicircular and thickened. The single, band-like postmental is in contact with two infralabials on each side. There follow three pairs of chin-shields; the 1st in contact; the 2nd, but for an abnormality on the right side, would be separated by a single scale; and the third pair by three scales. Three pairs of elongated postgenials follow the chin-shields. Six infralabials, in order of decreasing size, 2, 1, 3, 5, 6, 4.

The ear is marked by a pronounced bulge on each side, forming the greatest width of the head, and then, about four scales behind the mouth, a shallow, scale-covered, rather narrow depression running obliquely downwards and forwards.

Scales are 20 at midbody, subequal. Caudal scales larger, especially the mid-ventral set. Two moderately enlarged preanal scales. Scales from above vent to parietals, 82.

Body elongated, the distance between the end of the snout and the forelimb is contained nearly three and a half times in the distance between axilla and groin. Fore- and hindlimbs are rudimentary, slightly flattened, roughly club to paddle shaped, circled by small scales at the base, and then about five series of larger scales to the tip. The limbs fit back into grooves. The tail ends in a small rounded tubercle.

Measurements are given in Table 1.

TABLE 1.

Measurements of Specimens of Lygosoma truncatum *in mm.*

Number.	*	J. 6898.	A.C. 875.	A.C. 876.	A.C. 902.
Snout-vent	42	56	76	78	52
Tail	36	56	71	52†	44†
Snout-ear	—	7	7	8	6
Snout-forelimb	—	14	17	17	13
Axilla-groin	—	42	58	58	39
Head, length	4·5	7	7	8	6
Head, width	—	4	5	6	4
Forelimb, length	0·5	0·7	1	1·3	1
Hindlimb, length	1	1·2	2	2·3	1·7
Tail/Snout-vent	0·86	1·00	0·93	0·67†	0·85†
Axilla-groin/Snout-forelimb	—	3·00	3·41	3·41	3·00

* Peters' type. † Tail regenerated.

Ground colour of the body light rather honey brown, but the dorsum appears much darker because each scale is flecked and stippled with dark brown. Dorsally, and less marked laterally, each scale has a large, single, black dot at its anterior margin, forming six interrupted dorsal rows. These rows are most distinct on the neck. Lateral rows are prominent on the neck, but less marked on the body. The underside of the body is pale yellow. There are no black dots on the head, but much dark brown. The underside of the head from the plain mental is prettily marked until well back on the throat by longitudinal lines of dark brown along each scale row. The tail is dorsally and laterally much darker than the body. The yellow ventral area becomes narrower caudad until it dies out about two-thirds of the way down the tail leaving the posterior third blackish.

Variation in paratypes and J. 6898.: Peters' type is the only one of the five known specimens I have not examined, and for this I have relied on his original description (1877:528). J. 6898 is the specimen from Moreton Bay noted by Longman (1916:49)

now in the Queensland Museum. Of my three lizards A.C. 875 and A.C. 902 are paratypes. They both come from Wilson's Peak, where A.C. 875 was collected with the holotype. A.C. 902 was found nearby on 11. xii. 1940 under a log in a damp clearing. There seems to be little doubt that *L. t. monswilsonensis* occurs in New South Wales as well as in Queensland, because the three specimens described were found within a quarter of a mile of the border which follows the crest of the Macpherson Range and similar conditions of heavy rainfall with dense jungle and clearings are common to both north and south slopes.

In J. 6898 there are three pairs of nuchals plus an irregular scale on the right side between the 1st nuchal and parietal. The anterior shields are much less thickened than in A.C. 876. Colour and pattern are almost identical with A.C. 876. In A.C. 875 the postnasal and posterior loreal meet just above the 1st supralabial on the left side and by so doing exclude the anterior loreal from contact with that scale. This tendency is also noticeable in A.C. 876 and A.C. 902, whereas in J. 6898 the anterior loreal is about twice the size of the posterior, and the contact of the posterior loreal with the 1st supralabial is greatly narrowed. A.C. 875 is in process of sloughing. Absolute measurements of the limbs are given in Table 1. Some relative measurements are given in Table 2.

TABLE 2.

Ratio of Snout-vent to Limb Measurements in Lygosoma truncatum.

Number.	*	J. 6898.	A.C. 875.	A.C. 876.	A.C. 902.
Forelimb	84	80	76	60	52
Hindlimb	42	47	38	34	31

* Peters' type.

Acknowledgements.

I wish to thank Professor P. D. F. Murray and Professor E. A. Briggs, of the University of Sydney, and Dr. A. B. Walkom and Mr. J. R. Kinghorn, of the Australian Museum, for help and advice. Mr. George Mack, director of the Queensland Museum, kindly made available the specimen in his collections. Miss A. G. Burns, of Gordon, is to be thanked for the photographs.

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EXPLANATION OF PLATE VI.

Figs. 1-2.—*Lygosoma truncatum monswilsonensis*, n. subsp.

Fig. 1.—Dorsal view of holotype, No. A.C. 876.

Fig. 2.—Lateral view of forepart of A.C. 876.

Length of head and body, 78 mm.

Photos.—Miss A. G. Burns.

THE PETROLOGY OF THE COWRA INTRUSION AND ASSOCIATED XENOLITHS.

By N. C. Stevens,
formerly Linnean Macleay Fellow in Geology.

(Plate vii and 4 Text-figures.)

[Read 25th June, 1952.]

Synopsis.

The Cowra Intrusion consists of granodiorite, with a porphyry margin. The numerous xenoliths are described and their origin is discussed, in particular the pelitic xenoliths, the mineral assemblages of which include cordierite, sillimanite, spinel and almandine.

Introduction.

Some of the results of an extensive field and laboratory study of the Canowindra District have been recorded in two earlier papers (Stevens, 1950, 1951). In one of these (1951, p. 51) a preliminary account is given of an elongate mass of granodiorite which extends from the neighbourhood of Cowra northerly for about 16 miles. This is the subject of the present paper, and is named the Cowra Intrusion. It is characterized by an abundance of foreign xenoliths.

Field Relations.

The small map (Text-fig. 1) shows the extent, general character and relationships of the Cowra Intrusion. The map published in 1951 gives the geological setting of this pluton in the larger province. As indicated in the earlier paper, the mass is sill-like and almost conformable with the Silurian strata which it invades. These country-rocks, exposed on the eastern side of the intrusion, comprise slates, tuffs and occasional sandstones. Observations along this eastern margin suggest that the intrusion dips to the west at a moderate angle.

The slates are buff or greenish-coloured and of low metamorphic grade. Along certain zones they have been somewhat sheared, so that they have passed into phyllites. Analyses (Table 4) show that there is some variation in silica, magnesia and alkalies.

The country on the west of the Cowra Intrusion is made up mostly of the Canowindra Porphyry (a quartz-felspar-porphyry with sparsely-distributed red garnets). In many places this porphyry is a concordant intrusion, but in others it appears to be a flow. This type of rock also occurs on the east, separated from the Cowra pluton by the narrow strip of Silurian rocks already mentioned.

There is a general lack of contact metamorphism associated with the Cowra Intrusion; slates at the contact do not seem to have suffered appreciably, but biotite has been developed in some of the more arenaceous tuffs.

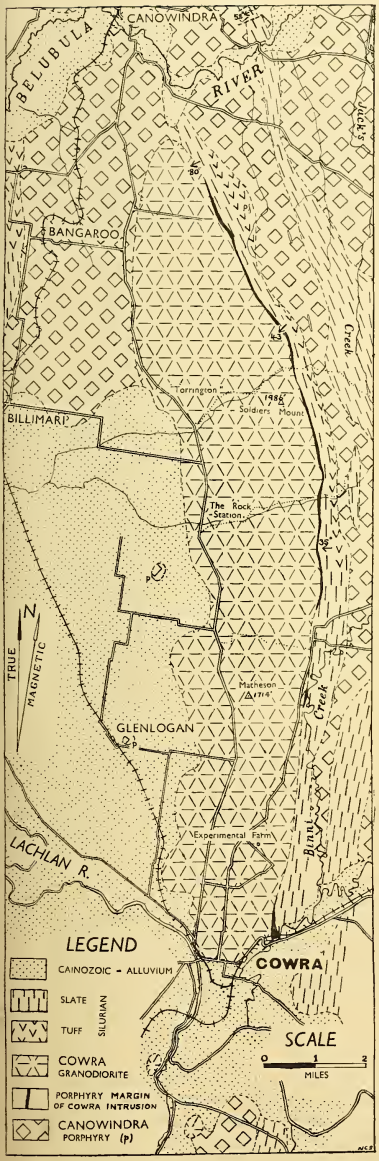
No pegmatites or aplites have been observed in or near the Cowra pluton and quartz veins are relatively scarce.

The Cowra Intrusion can be divided into (*a*) the Cowra Granodiorite and (*b*) the porphyry margin.

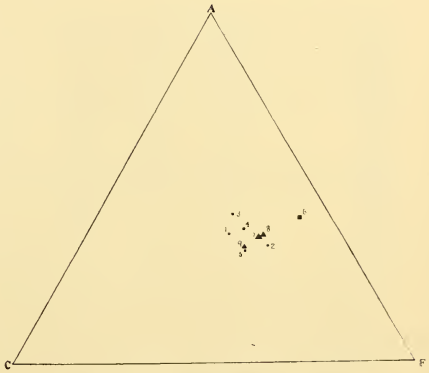
(*a*). The Cowra Granodiorite constitutes the major part of the intrusion, being fairly uniform in constitution and texture except for numerous and varied xenoliths. These are dealt with below. The assimilation of xenolithic material has resulted in a rock which is not a normal granodiorite, for hornblende is absent.

(*b*). The granodiorite-porphyry margin occupies a narrow portion of the pluton, along its eastern side. The width of outcrop varies (up to a maximum of 200 yards) and a complete gradation is seen from the granodiorite into porphyritic types.

Another notable feature of the Cowra Intrusion is the occurrence of abundant red garnet which seems to be associated with the numerous xenoliths. The garnet has been remarked upon by Dr. W. R. Browne (1929, p. xxii), who suggested that it may have been derived from strata through which the granodiorite magma passed.



Text-fig. 1.—Map of the Cowra Intrusion and Associated Xenoliths.



Text-fig. 2.—Analyses of Table 1 plotted on an A-F-C diagram. ● (1-5), granodiorites; ■ (6), gneiss; ▲ (7-9) porphyries and dacite. The diagram emphasizes the similarity in chemical composition between the granodiorites, porphyries and dacite. The Albury Gneiss is quite different, although the silica percentage is comparable.

Petrology.

(*a*). The Cowra Granodiorite.

The normal rock is mottled, phanerocrystalline, coarse to medium-grained, with clear quartz, dull white felspar and lustrous well-formed biotite. Red garnet is often seen, especially near the south end of the intrusion.

Under the microscope one notes the absence of hornblende and the presence of muscovite which is not primary. The plagioclase (andesine Ab_{58}-Ab_{62}) is idiomorphic with zoning and twinning invariably present. The alteration is generally strongly developed, deuteric sericitization and katamorphic kaolinization being the rule. Some epidote and clinozoisite are occasionally developed. Biotite is idiomorphic, red-brown in colour and showing change in varying degrees to chlorite, epidote (sometimes radiating), sphene and ilmenite, the last two products indicating a not inconsiderable amount of titanium in the mica.

Table I.

	1	2	3	4	5	6	7	8	9
SiO_2	67·64	67·67	67·75	66·13	67·07	66·94	66·30	67·17	66·63
Al_2O_3	14·54	14·50	16·11	16·83	15·55	16·65	15·26	14·86	14·86
Fe_2O_3	2·24	0·87	0·50	1·11	0·50	0·40	1·28	0·43	2·01
FeO	4·05	3·78	4·00	4·17	3·38	4·77	4·18	3·87	3·75
MgO	1·13	2·21	0·79	1·83	1·69	2·19	2·32	1·61	1·73
CaO	2·70	2·18	2·68	3·26	2·97	0·94	2·87	2·84	2·55
Na_2O	3·04	2·38	2·60	2·25	3·21	2·11	2·22	2·48	2·99
K_2O	3·12	3·42	3·42	3·14	3·80	3·56	3·08	3·77	3·78
H_2O+	0·93	1·81	0·96	1·68	1·02	2·13	0·92	0·90	0·73
H_2O-	0·23	0·11	0·20	0·23	0·15	0·12	0·28	0·12	0·47
TiO_2	0·94	0·61	0·85	tr.	0·61	0·60	0·80	0·87	0·77
P_2O_5	0·12	tr.	0·09	tr.	0·23	0·01	0·08	0·53	0·06
MnO	0·04	tr.	tr.	0·07	0·04	0·06	0·06	0·07	0·05
S	abs.	—	—	—	0·04	—	—	0·02	—
CO_2	—	—	—	—	—	—	—	0·20	—
	100·72	99·54	99·95	100·70	100·37	100·48	99·65	99·74	100·38
S.G.	2·76	—	2·68	2·68	—	—	2·74	—	2·72

Loss of O for S taken into account for analysis No. 5.

1. Cowra Granodiorite. 4½ miles N. of Cowra; grid reference 680254, Cowra 1-Inch Military Map. Anal. N. C. Stevens.
2. Grey Biotite-Granite. East of Lot 8, Section VII, Par. of Cndgewa. Anal. F. F. Field, A. B. Edwards and J. G. Easton. *Proc. Roy. Soc. Vict.*, 50, 1937: 82.
3. Granodiorite. Quarry, Gellibrand Hill, Broadmeadows. Anal. H. C. Richards. F. L. Stillwell. *Ibid.*, 24, 1911: 156.
4. Granodiorite. S.W. of Bulla. Anal. F. Watson. A. V. G. James. *Ibid.*, 42, 1929: 323.
5. Granodiorite. Talbot Drive, Marysville. Anal. E. S. Hills. *Geol. Mag.*, 69, 1932: 145.
6. Cordierite-bearing Gneiss. Weir Quarry, por. 65, Par. of Thurgona (Albury, N.S.W.). Anal. G. A. Joplin. Proc. Linn. Soc. N.S.W., 72, 1947: 87.
7. Granodiorite-porphyry. 3¾ miles E. of Bangaroo Railway Station. Grid reference 664416 on Canowindra 1-Inch Military Map. Anal. N. C. Stevens.
8. Rhyodacite. Wood's Point Road, Marysville. Anal. E. S. Hills. *Geol. Mag.*, 69, 1932: 145.
9. Canowindra Porphyry (garnetiferous). 6 miles E. of Canowindra. Grid reference 731476 on 1-Inch Military Map (Canowindra).

Orthoclase, much subordinate to the plagioclase, is allotriomorphic, and the abundant allotriomorphic quartz shows a variable grainsize up to a maximum of 5 mm. diameter. Sub-parallel cracks and undulose extinction are notable, and the interference figure is frequently rendered biaxial by strain effects. Some intergrowth with orthoclase has occurred around the quartz margins, and this is more widespread when the proportion of orthoclase in the rock is higher. Zircon and magnetite are minor accessories.

Muscovite, sometimes in quite large flakes, replaces plagioclase and is intergrown with quartz in interstices. The mode of occurrence of the mica suggests that it has effected greisenization during a late-magmatic phase before the magma had completely consolidated. It is possible that some of the muscovite is due to reaction between magma and xenoliths.

An analysis of the granodiorite, as far as possible free from xenoliths, is given below (Table 1), where it is compared with its porphyritic marginal phase, the Canowindra Porphyry, and some Victorian granodiorites in which garnet has been noted in association with xenoliths rich in ferromagnesian minerals.

The Cowra Granodiorite differs from the other rocks in possessing higher contents of soda and total iron, along with lower alumina. Nevertheless the chemical data tabulated emphasize the close correspondence in composition of the Cowra rock with many Victorian granodiorites and comagmatic rhyodacites.

Potash in the Cowra rock is normal, although there is a limited amount of orthoclase; prominence of biotite and muscovite accounts for this. The dominance of intermediate plagioclase expresses itself in the relatively high percentage of soda.

(*b*). The Porphyry Margin.

The typical porphyry from Soldier's Mount shows phenocrysts of quartz, biotite, plagioclase and occasional orthoclase in a fine-grained groundmass of the same minerals. Quartz is subidiomorphic, corroded and cracked, and has notable sub-parallel trains of minute inclusions. Sometimes it shows marginal intergrowth with the felspar of the groundmass. The plagioclase, somewhat sericitized, is andesine (Ab_{60}). Biotite is deep reddish-brown in colour and contains inclusions of zircon and rutile, the latter sometimes exhibiting sagenitic webs.

The porphyries are more melanocratic than the granodiorite and become progressively darker as the slate contact is approached. Under the microscope these darker phases become enriched in plagioclase and biotite and deuteric alteration is more pronounced.

Near the margin of the intrusion cordierite appears as small xenocrysts; under the microscope these are seen to be subidioblastic and veined with yellow pinite, and concentration of the cordierite occurs in certain parts of the rock associated with clots of green mica. As in the granodiorite, these minerals are the result of contamination.

In some specimens the quartz-felspar groundmass appears to have been recrystallized, but it is unlikely that the granodiorite was a later and separate injection, as there is a complete gradation between granodiorite and porphyry, and the width of the porphyry selvedge is fairly uniform along the eastern side of the granodiorite.

Analysis No. 7 in Table 1 is of a granodiorite-porphyry from the north-east end of the Cowra Intrusion. Compared with the granodiorite it possesses slightly less silica, iron and soda, and a little more alumina and magnesia (see also Text-fig. 2).

(*c*). The Xenoliths.

Xenoliths are much more numerous and varied in the main mass of the granodiorite, so our attention will be mainly confined to these. They may be divided into five groups on the basis of composition, and to some extent of implied origin. Thus we have (1) pelites, (2) psammites (including psammopelites), (3) calcareous xenoliths, (4) igneous xenoliths and (5) granitized xenoliths.

The assemblages found are listed in Table 2, with the names of the less common minerals enclosed in brackets.

(1) Pelites.

Xenoliths derived from pelites constitute probably the most abundant type in the Cowra Intrusion. They are dark and fine-grained, up to several inches in length, and mostly show signs of the original bedding. They are sheathed in micaceous reaction-rims, and in the smaller xenoliths the reaction-rim may make up the greater part, giving them the appearance of biotite-schists.